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		First Named Inventor or Application Identifier	Snorre Kjesbu
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Title of Invention	An Arrangement And Method For Improved Communication Between Participants In A Videoconference		

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Sir:

This application claims priority under 35 U.S.C. §119 or 365 to the foreign/international application(s) identified below:

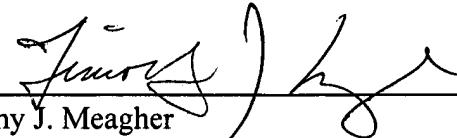
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Application No.	Country	Filing Date	Yes	No
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Application No.	Country	Filing Date	Yes	No
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Application No.	Country	Filing Date	Yes	No
			[]	[]
Application No.	Country	Filing Date	Yes	No

[] A certified copy of the priority document, [country] Application No. [], filed [], was previously filed in the parent application, U.S. Application No. [], filed [].

Respectfully submitted,

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▷ Det bekreftes herved at vedheftede dokument er nøyaktig utskrift/kopi av ovennevnte søknad, som opprinnelig inngitt 2003.04.07

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TITTEL:

Arrangement og fremgangsmåte for forbedret kommunikasjon
mellan deltagere i en videokonferanse

FULLMEKTIG:

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Field of the invention

The present invention relates to videoconferencing systems and in particular to video capturing and displaying systems providing eye contact between videoconference participants.

5 Background of the invention

Face-to-face conversation is usually recognized as the preferred form of human communication. Therefore, videoconferencing systems purpose to achieve communication being as close to real face-to-face conversation as
10 possible.

Typical video conferencing systems include a display screen and a camera for each site. During video conferencing, the user(s) of a first site observes an image of the second site on the display screen. At the same time, an image of
15 the first site is captured by the camera and projected on the display screen at the second site. The user(s) at the second site observes the image of the first site on the second screen while a camera at the second site simultaneously captures an image of the second site and
20 projects that image upon the screen at the first site. In the prior art, the projector and the camera associated with the same site operate on different optical paths. When a user at the first site is looking at the image of the second site on the first screen, he/she will be looking away from the camera. For example, consider a video
25 conferencing system that uses a conventional monitor as the display device and a camera mounted on the side, top or bottom of the monitor housing. Because of the closeness of user to the monitor and the camera being positioned at the periphery of the monitor's display screen, the perspective or angle at which the image of the user is captured is not optimum and the image captured shows the user as looking
30 away from the camera. Thus, the first camera receives an image of the first user that is indirect. As the image from

the first camera is projected onto the second screen, the second user also sees an indirect image of the first user (i.e., the second user sees the first user's image as looking away from the line of sight of the second user), and thus there is no "eye contact" between users. Only when the first user is looking directly at the camera (and not at the image of the second user upon the first screen) will there be eye contact between the second user (looking at the second screen) and the first user (looking into the camera). However, users rarely, if ever, change their head position and eye contact to focus on the camera instead of the display, and even when they do, such adjustments in user head position are not natural and require significant concentration and effort. Such prior art systems are problematic because of their inability to capture a direct, full-face image of the user. In summary, there is never a time when both users are looking directly at each other, seeing full-face images upon the screen and having eye contact.

US 5,400,069 discloses a videoconferencing system providing eye contact by means of a special purposed back projection screen. Both projector and camera are positioned behind the screen. The screen is simultaneously translucent with respect to the projector and transparent with respect to the camera and includes segments that discriminate between projected light and light to be captured by the camera based upon polarization or angle. Light from the opposite side of the camera and projector side, e.g. reflected light from the participants, is passed and vertical polarized through the screen, and captured by the camera. Light from the projector reflected on the screen is horizontal polarized, and will not be captured by the camera, because it allows absorption of vertical polarized light only. Thus, participants looking at the projected picture on the screen will also seem to look at the camera behind the screen, and eye contact will be established.

However, US 5,400,069 requires a tailored and back projected screen. Front projections on a simple screen or even on a wall are today extensively adapted as a preferred solution for displaying presentations and information to a group of people in a designed meeting room. This display technology should also be used as display device for videoconference with eye contact features.

Thus, there is a need for a videoconference system with conventional front projection providing eye contact without capturing interfering light from the projector.

Summary of the invention

The features defined in the independent claims enclosed characterise this arrangement and method.

In particular, the present invention discloses an arrangement of a videoconference end-point at least including a light projection apparatus emitting a beam of light creating one or more images on a projective surface, and a light capturing means, residing within said beam of light, capturing a view, wherein the arrangement includes a field generator means adapted to generate an area of light or absence of light in said beam replacing a part of and/or adding a part to said one or more images, to cover at least a part of said light capturing means. The invention also discloses a corresponding method.

25 Brief description of the drawings

In order to make the invention more readily understandable, the discussion that follows will refer to the accompanying drawings,

Figure 1 is a block diagram of a videoconferencing system employing a preferred embodiment of the present invention,

Figure 2 illustrates an end-point in operation according to a preferred embodiment of the present invention,

Figures 3 - 6 illustrate various examples of placements of light sensors around a videoconferencing camera.

5 Figure 7 illustrates an end-point in operation according to an alternative embodiment of the present invention,

Best mode of carrying out the invention

In the following, the present invention will be discussed by describing preferred embodiments, and by referring to 10 the accompanying drawings. However, people skilled in the art will realize other applications and modifications within the scope of the invention as defined in the enclosed independent claims.

15 The present invention is to use standard front projection equipment as generator for displaying the image at videoconferences. That is, the invention is adapted to allow use of existing presentation equipment already installed in meeting rooms, lecture rooms etc. as the display means of a video conference end-point, while still 20 providing eye contact between participants on different sites. Referring to figure 2, an end-point arrangement according to an example embodiment of the present invention is shown. A user is watching an image of the far end site projected upon a linen cloth by a projector receiving the 25 picture from the end-point codec. To achieve good eye contact, the camera of the end-point is placed substantially in the middle of the projected image supported by e.g. a bar. It should be possible to move the position of the camera in at least one direction, manually, 30 or optionally by means of an engine drive. In the arrangement of figure 2, the camera is movable in the vertical direction.

In conventional videoconferencing systems using projectors as displaying means, placing the camera in front of the screen would not be recommended because the camera would capture the light from the projector, thus presenting a disturbed image at the far end side. This problem is solved by the present invention by forming a black area or spot (or an area/spot of alternative light or absence of light) in the image substantially covering the light input of the camera, having an appropriate position and size relative to the camera, or the light input of the camera, for preventing deterioration of the image transmitted to the far end site(s).

The system of one embodiment of the invention includes means for camera position detection and black spot generation. The camera position detection means must output the positions relative to the screen or the pixels in the image corresponding to the required area of the light input of the camera, normally the camera lens, into which light from the projector is prevented to fall. In one embodiment, the light detection means includes one or more light sensors, preferably light absorbing diodes, arranged in the surroundings of the camera lens as exemplified in figures 3 - 6. The number of sensors is determined by the desired accuracy of the black spot relative to the light input of the camera, and the freedom of movement of the camera. E.g. if the horizontal position of the camera is fixed, and a square shaped black spot is acceptable, only one light sensor would be required, as illustrated in figure 3, where the light sensor is positioned right below the camera lens. In this case, the area size and the vertical edges of the squared black spot are known, and consequently, the vertical edges and the relationship between the horizontal edges of the square are known. By moving the position of the lower horizontal edge of the black square upwards from an initial position under the sensor, the light sensor may signalize when the light absorption is increasing (or decreasing if the edge position is adjusted downwards from

initially above the sensor). The position of the lower horizontal edge is then set to current position, and the position of the upper horizontal edge is set correspondingly according to said fixed relationship. Of course, the light sensor could also be placed above the camera lens, using the upper horizontal edge as the guidance edge for positioning the two horizontal edges.

If the positions of the vertical edges are not fixed, e.g. due to an additional engine drive in the horizontal direction, an additional light sensor must be placed on the right or left side of the camera lens as illustrated in figure 4. The positions of the vertical edges are then determined as explained above by moving one of them in the horizontal direction and stopping at a change of light absorption in the sensors.

When the size of the squared black spot should be variable, e.g. due to changes in the direction and tilt of the camera, light sensors on both sides of the lenses as well as on the upper and under side are required, as shown in figure 5. The edges are then adjusted completely independently from each other.

Other patterns of light sensors around the camera lens may also be applicable dependent on the required accuracy, the shape of the black spot, and the camera's freedom of movement. One example is shown in figure 6, wherein the black spot area is defined by four corner light sensors.

In another embodiment of the present invention, input to the camera position detection is captured by the camera lens itself. The shape of the black spot would then correspond to the shape of the camera lens, which in most cases is circularly shaped. The black spot generator and the camera lens must cooperate to find the optimal position and size of the black spot. As already indicated, the area of the displayed picture occupied by the black spot should

be as small as possible, but at the same time sufficiently large to prevent the camera to capture interfering light from the projector.

There are various ways of initialising the system according to the present invention. In the case of a square shaped black spot and light absorbing sensors, the black spot initially covers the whole display field of the screen. One or at least some of the edges then moves towards the centre of the original black spot until the sensor(s) associated to the respective edge sense(s) the camera position. The sensor(s) then transmit a signal to the black spot generator indicating that the current edge position(s) is/are to be used. The signal transmission could be triggered when a certain percentage of projector light is sensed by the sensor(s), so that the movement(s) stop(s) at a time when the edge(s) is/are crossing the light sensor. The only requirement to the camera positioning is that the camera has to reside within the initial black spot (before adjustment).

Alternatively, the black spot may initially reside within the camera lens. One or at least some of the edges then move(s) outwards to the associated sensor(s) until it/they sense(s) decreasing or absence of projector light. The sensor(s) then transmit a signal to the black spot generator indicating that the current edge position(s) is/are to be used. As before, the signal transmission could be triggered when a certain percentage of projector light is sensed by the sensor(s), so that the movement(s) stop(s) at a time when the edge(s) is/are crossing the light sensor.

In this case, the black spot generator must know the position of the camera to place the initial black spot within the camera lens.

In the case of a circular shaped black spot, when the light capturing means of the camera itself provides input to the camera position detection, the initialization may be

carried out by first placing a small circular shaped black spot in the centre of and within the camera lens. Then the black spot generator magnifies the spot until the projector light that is passing the camera lens approximates zero, or
5 in other words, until the projector light is no longer interfering with the picture captured by the camera lens. When this occurs, the black spot generator is provided with a signal to indicate that the current size of the black spot is appropriate, and the generator stops magnifying the
10 spot. In this case, the black spot generator must know the position of the camera to place the initial circularly black spot in the centre and within the camera lens.

The purpose of the initialisation, in addition to protecting the camera lens from projector light all from
15 the start, is to define a reference position and size of the black spot that may be used at changes in the position, orientation and tilt of the camera during operation. According to a preferred embodiment of the invention, one unity of change corresponds to a predefined number of
20 pixels of the image projected on the screen. As an example, consider the arrangement of figure 2. Here, repositioning of the camera is allowed in one direction only, e.g. provided by an engine drive moving the bar to which the camera is attached, in the vertical direction. The
25 movements are carried out one step at a time, wherein one step represents a fixed distance of movement. This distance of movement may easily be converted to a predefined number of pixels by the black spot generator dependent on the size of the image. Now, when the engine drive moves the camera a
30 number of steps upwards or downwards, the black spot generator regenerates the black spot by moving the upper and lower edges the number of steps times said predefined number of pixels. In this way, the black spot will follow the movements of the camera in the vertical direction. In
35 the case of minimizing or magnifying the image projection on the screen, the predefined number of pixels should be changed accordingly. For this purpose, the black spot

generator is preferably in communication with the zooming functionalities of the projector. Similar repositioning mechanism in the horizontal direction and in the case of a circularly shaped black spot will be obvious for a person skilled in the art.

Changes in orientation and tilt of the camera would also require changes in the positioning and optionally the size of the black spot. A degree unit of orientation or tilt may also be associated with a number of pixels in the image,

and a regeneration of the black spot representing a movement is carried out corresponding to the amount of orientation or tilt. A change of orientation or tilt may similarly correspond to a size adjustment of a predefined amount of pixels.

In an alternative embodiment of the invention, the black spot follows the movements of the camera independently of the movement source. This is realised by a camera position detector including one or more auxiliary cameras mounted behind the main camera directed towards the screen. The auxiliary camera(s) capture one or more spots of the image displayed on the screen. The image spots are transmitted to the black spot generator, which is configured to recognize the image spots and to identify their relative positions within the image. Taking into account the direction of the auxiliary cameras, the distance between the camera and the screen, and the orientation and tilt of the camera (optionally detected by one or more simple telemeters), the position of the camera within the image area could easily be calculated. Thus, the black spot generator is allowed to generate a black spot always "attached" to the camera within the image area.

In still another embodiment of the invention, the main camera itself is again used as input for the camera position detector. When the amount of projector light increases due to camera movement relative to the projector,

a process is initiated in the black spot generator generating a short glimpse of a predefined dummy light value (e.g. black) in all the image pixels, one at a time, not noticeable for an image viewer. At the time the camera 5 captures this light value, the black spot generator notices which pixel that currently is being assigned the dummy value. When the process has gone through all the pixels, those pixels noticed by the black spot generator then forms the regenerated black spot in the image. This process may 10 also be used at initialization, starting with e.g. a black image being traversed by a light value allowing the black spot generator to similarly detect the pixels forming the initial black spot.

In a further embodiment of the present invention, the 15 camera position detector means is incorporated in the screen. By providing the screen with light sensitivity feature, it is adapted to detect the area on which the image is projected. In addition, as the camera is placed within the spotlight of the projector, it forms a shadow on 20 the screen. The relative position of the shadow in the projected image will also be detectable by the light sensitivity features of the screen. Since the camera itself forms the shadow, the black spot could coincide with the shadow. The position and size of the shadow could be an 25 approximate indication of the size and position of the black spot, or the black spot could be a direct copy.

Generally, the task of the black spot generator is to determine which of the image pixels that is to form the black spot on basis of the input from the camera position 30 detector. It also has to regenerate the black spot to adjust its position and optionally the size during a conference according to changes in the input from the camera position detector. The black spot generator may be an integrated part of the codec or the projector associated 35 with the end-point equipment, or as a standalone device in communication with one or both of them. In all cases, the

values of pixels that the black spot generator has determined to form the black spot is removed by a black or another non-interfering colour value, either right after the decoding process in the codec, or in connection with the image generation process in the projector.

The principle of the present invention is not limited to the end-point arrangement wherein the camera is placed in front of the screen or the linen cloth. In addition, when the camera is fixed on, integrated in, or even mounted behind the screen, the inventive features of the present invention would also be useful. When the camera is in a fixed position on the screen, only the initialization part of the present invention is required, but a black spot still has to be generated. When the camera is placed behind the screen, the screen has to be translucent with respect to the projector light to reflect the projected image to the viewers, but transparent with respect to the room light allowing the camera to "see" through the screen. This kind of screen technology is known in the art of optics, and is i.a. used in projecting advertisement on shop windows.

Note that the specific terms used in the above description are not limiting the scope of the invention as defined in the independent claims. As an example, the term "camera position detector" does not exclude the case of separating the light input of the camera with the rest of the camera, as when the camera lens is separated from the camera by an optical guide. In this case, it is the position of the lens, and not the camera, that is controlling the position and size of the spot. Further, the spot may be of any shape, and may be filled with any kind of light (or absence of light) that is appropriate for the specific application. Further, the beam of light from the projector apparatus is not limited to create only one image. An example of the latter is shown in figure 7. Here, the beam of light creates two images on the screen, and the area of black light is formed as a horizontal H.

The present invention allows for placing and positioning the videoconference camera wherever desired in the projected image to get an optimal eye contact with the participants on the other end, without the use of any
5 special or complex aperture.

Further, the possibility of using standard projectors and screens for the projection of the image allows users to employ existing meeting room displaying equipment as a part of the videoconferencing equipment.

- 10 The invention provides good flexibility for tilting, panning and lifting the camera into the perfect position for optimal communication between the participants of a videoconference.



P a t e n t c l a i m s

1. An arrangement of a videoconference end-point at least including a light projection apparatus emitting a beam of
5 light creating one or more images on a projective surface, and a light capturing means, residing within said beam of light, capturing a view,
c h a r a c t e r i z e d i n

10 field generator means adapted to generate an area of light or absence of light in said beam replacing a part of, and/or adding a part to, said one or more images, to cover at least a part of said light capturing means.

2. An arrangement according to claim 1,
15 c h a r a c t e r i z e d i n

20 positioning detector means adapted to detect position, orientation and/or tilt and/or changes in position, orientation and/or tilt of the light capturing means relative to said one or more images and to provide information of the position and changes to said field generator means for placing and adjusting said area of light or absence of light to cover at least a part of said light capturing means.

25 3. An arrangement according to claim 2,
c h a r a c t e r i z e d i n that said position
detector means includes one or more light sensors positioned close to and/or around said light capturing means adapted to sense and signalise to said field generator means when an edge of said area of light or
30 absence of light is crossing one of the sensor(s).

4. An arrangement according to claim 2,
characterized in that said position
detector means includes said light capturing means adapted
to sense and signalise to said field generator means when a
5 predefined amount and/or distribution of said light beam is
captured.

5. An arrangement according to claim 2,
characterized in that said position
detector means includes one or more auxiliary camera(s)
10 directed towards the projective surface each capturing a
respective spot of the one or more images that is being
transmitted to said field generator means wherein the
captured spot(s) is/are identified with respect to
position(s) within the one or more images, which, in
15 addition to the angle and/or position(s) of the auxiliary
camera(s) relative to light capturing means, is/are used to
derive the position, orientation and/or tilt of the light
capturing means.

6. An arrangement according to claim 2,
20 characterized in that said position
detector means is adapted to generate a glimpse of a
predefined dummy light in all pixels of said one or more
images, one or a number of pixels at a time, and to detect
when the positioning detector means captures the dummy
25 light and simultaneously noticing which of the pixels at
the time being having the dummy light value assigned,
wherein the spot generator means is adapted to define the
area by the noticed pixels.

7. An arrangement according to claim 2,
30 characterized in that said position
detector means includes the projective surface adapted to
sense said one or more images and a shadow formed by the
light capturing means, wherein the field generator means is
adapted to define the area from the sensed shadow.

8. An arrangement according to one of the claims 2 - 7, characterized in that said field generator means is adapted to initialize the position and/or size of said area of light or absence of light by initially generating the area to cover substantially the whole of said one or more images and then shrinking the area until said position detector means detects one or more edges of said area.

9. An arrangement according to one of the claims 2 - 7, characterized in that said field generator means is adapted to initialize the position and/or size of said area of light or absence of light by initially generating the area to cover a part of said one or more images residing within said light capturing means and then expanding the area until said position detector means detects one or more edges of said area.

10. An arrangement according to any of the preceding claims, characterized in that said field generator means is adapted to use an initiate position and/or size of the area as reference, and to carry out subsequent adjustments of position and/or size of the area by associating a mechanical distance of movement of the light capturing means with a corresponding deviation of the area relative to the reference in image pixels.

11. An arrangement according to one of the claims 2 - 10, characterized in that the position detector means is integrated in or connected to a codec and/or the light capturing means.

12. An arrangement according to any of the preceding claims, characterized in that the light capturing means is placed in front of or behind the projective surface.

13. A method of a videoconference end-point at least including a light projection apparatus emitting a beam of light creating one or more images on a projective surface, and a light capturing means, residing within said beam of light, capturing a view,
5 characterized in

generating an area of light or absence of light in
said beam replacing a part of, or adding a part to,
said one or more images, and
10 adjusting at least the position of said area of light
or absence of light to cover at least a part of said
light capturing means.

14. A method according to claim 13,
characterized in

15 detecting position, orientation and/or tilt and/or
changes in position, orientation and/or tilt of the
light capturing means relative to said one or more
images by means of light sensor(s) and/or the light
capturing means itself, and
20 providing information of the changes to adjust said
area of light or absence of light according to the
detection.

15. A method according to claim 13,
characterized in

25 capturing one or more spots of the one or more images
from a known position and/or angle relative to the
light capturing means,

identifying the captured spot(s) with respect to
position(s) within the one or more images,

deriving the position, orientation and/or tilt of the light capturing means out from the identified captured spot(s) and said known position and/or angle.

16. A method according to claim 13,
5 characterized in

generating a glimpse of a predefined dummy light in all pixels of said one or more images, one or a number of pixels at a time, and

10 detecting when the dummy light is captured by the light capturing means and simultaneously noticing which of the pixels at the time being having the dummy light value assigned,

defining the area of light or absence of light by means of the noticed pixels.

15 17. A method according to one of the claims 13 - 16,
characterized in

initializing the position and/or size of said area of light or absence of light by

20 initially generating the area to cover substantially the whole of said one or more images,

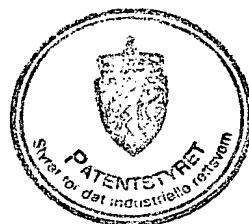
shrinking the area until said one or more edges of said area is/are detected.

18. A method according to one of the claims 13 - 16,
25 characterized in

initializing the position and/or size of said area of light or absence of light by

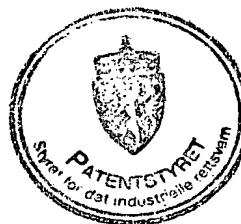
initially generating the area to cover a part of
said one or more images residing within said
light capturing means,

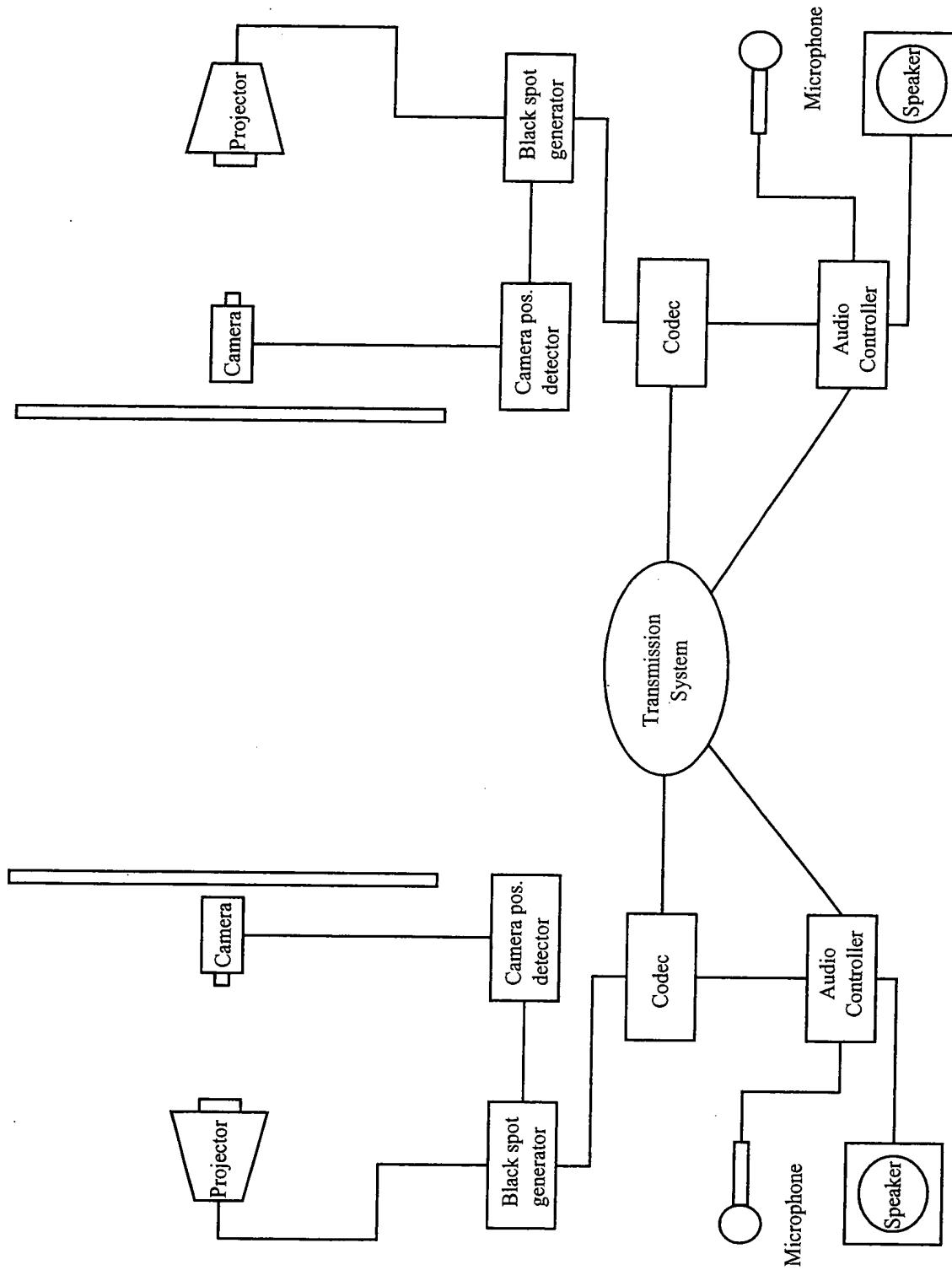
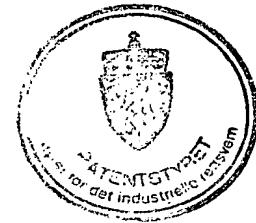
expanding the area until one or more edges of
said area is/are detected.



A b s t r a c t

The present invention discloses an arrangement and a method of a videoconferencing end-point providing eye contact between users at different sites. The invention allows for placing the conference camera in the light beam of a projector apparatus without degrading the camera-captured view by the projector light. This is provided by generating a black spot in the light beam covering the camera lens, and by adjusting the position and/or size of the black spot according to a camera position detector, which may be the camera itself or one or more light sensors around and close to the camera lens.



**Figure 1**

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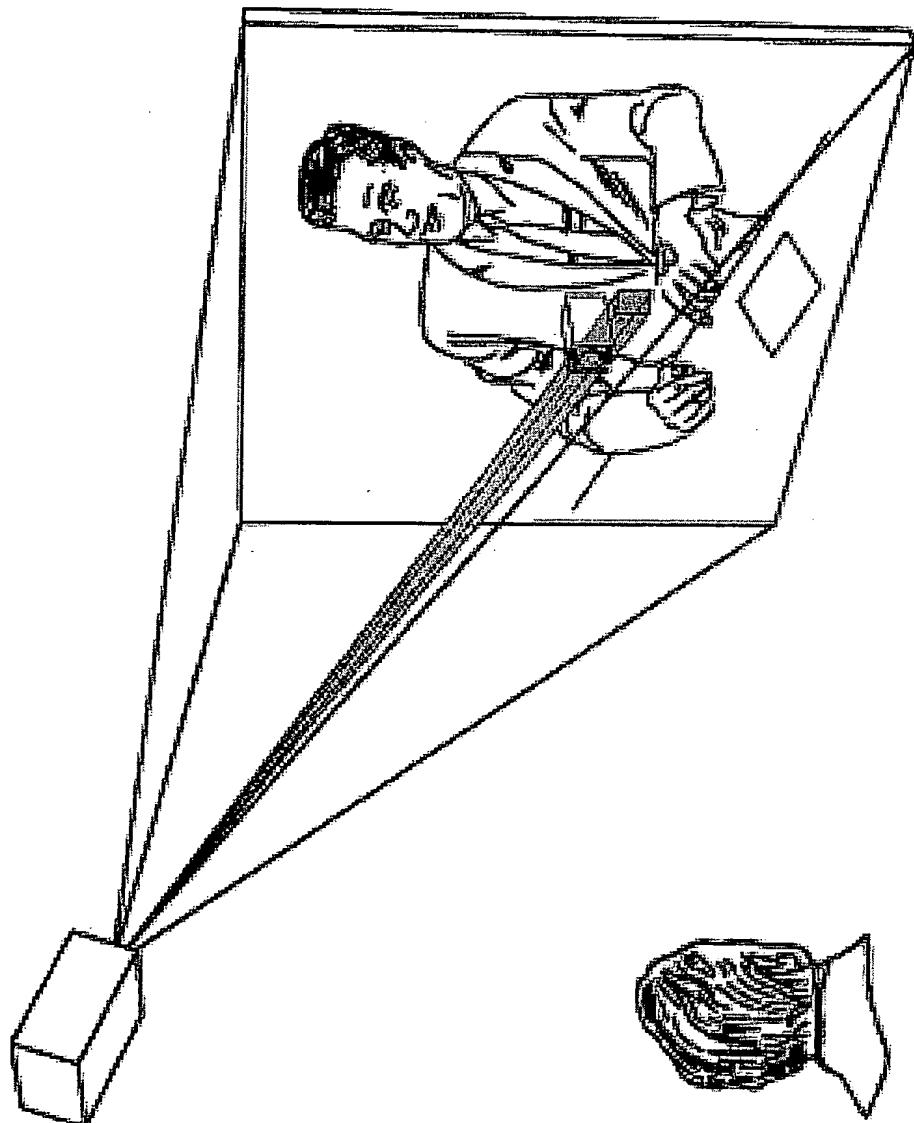


Figure 2



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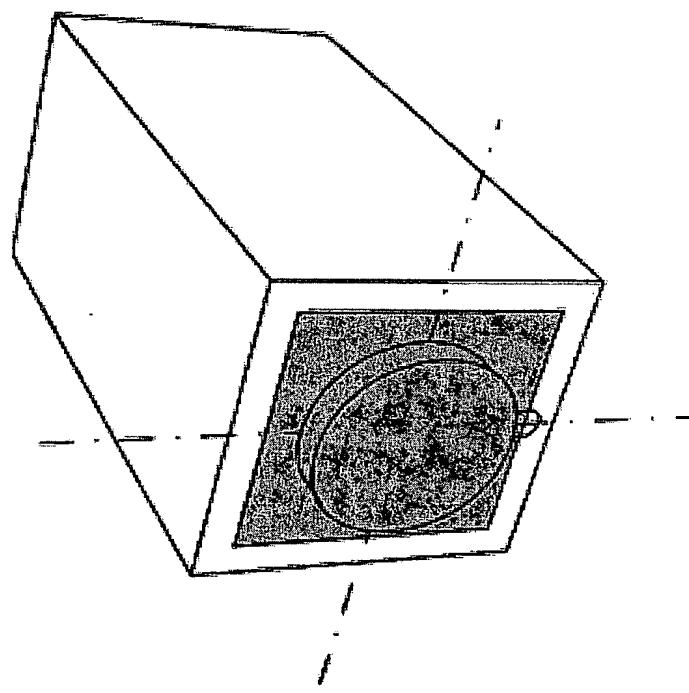


Figure 3



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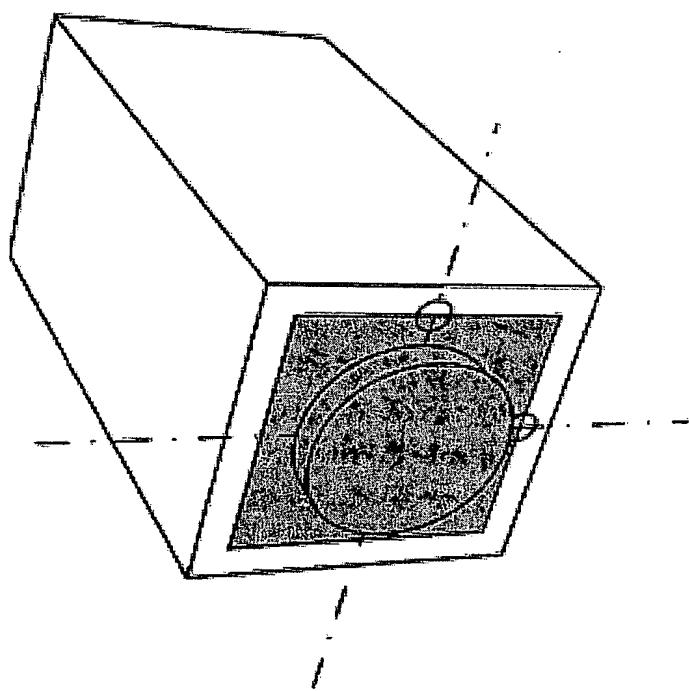
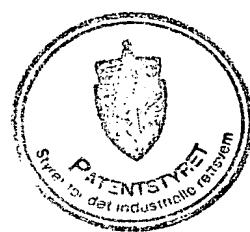


Figure 4



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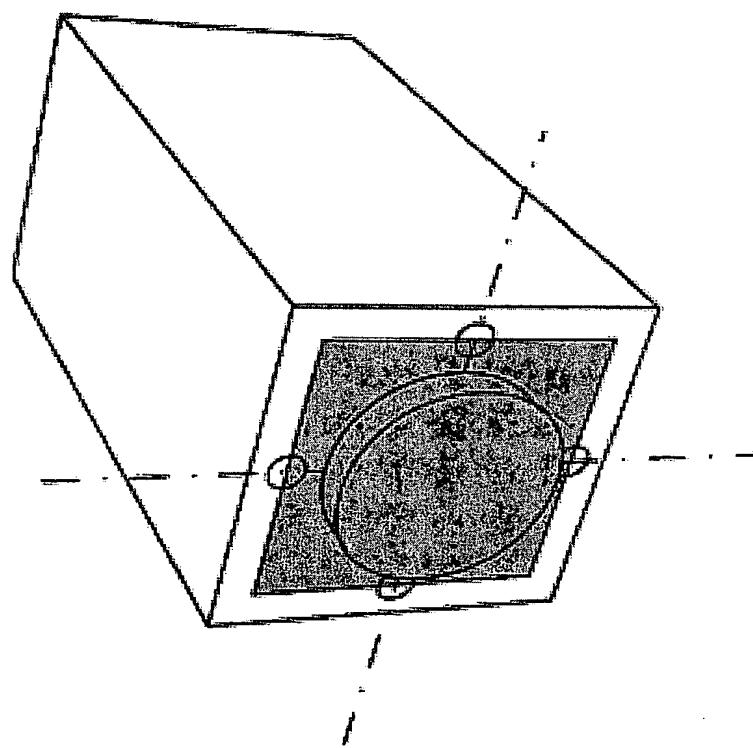
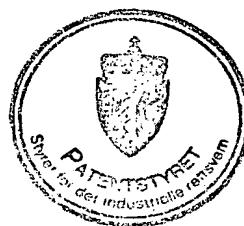


Figure 5



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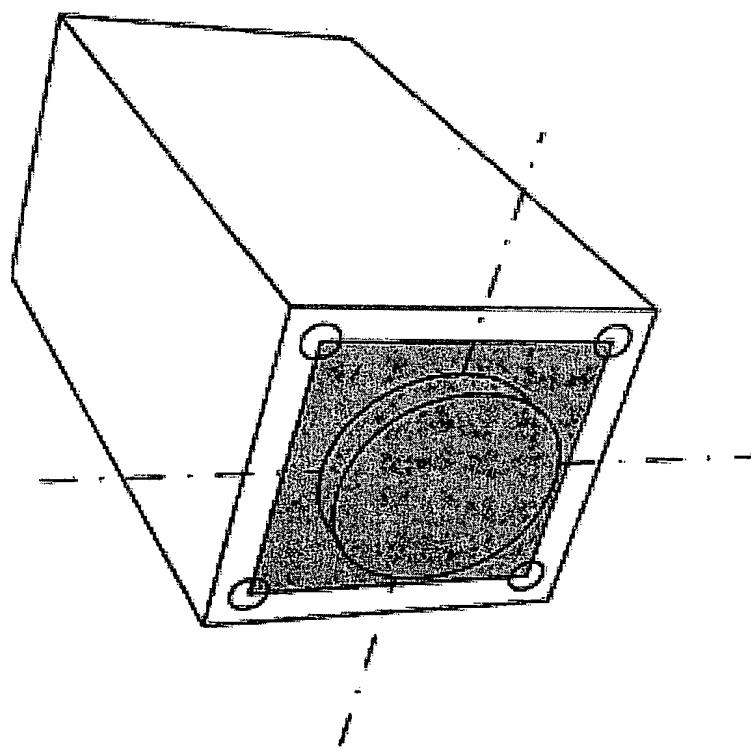
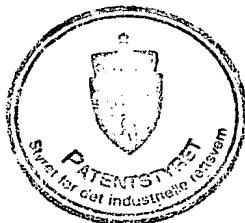


Figure 6



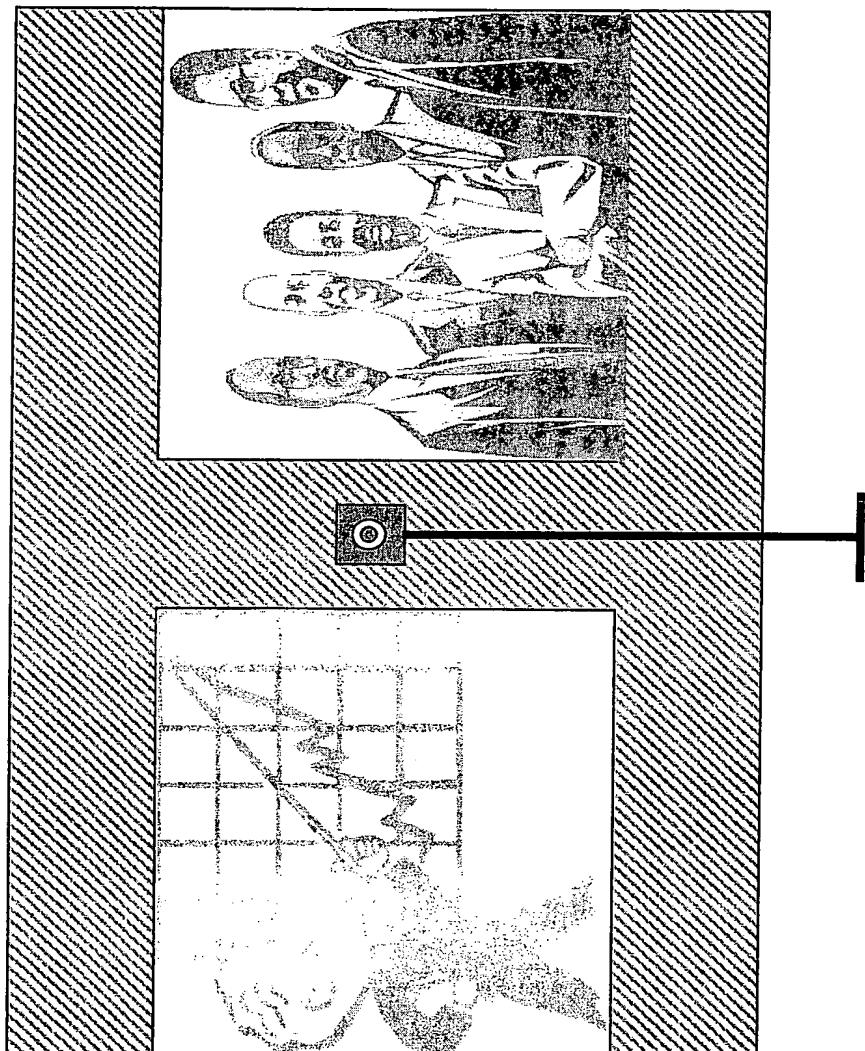


Figure 7

